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CONTEMPORARY IDEAS ON THE NATURE OF BACTERIOPHAGE

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If some speculative hypotheses of foreign Weismannist scientists are disregarded, the prevalent idea on the nature of the bacteriophage can be classified in four main categories:

1. Bacteriophage is an enzyme eliminated by the bacteria in the course of their decay. The presence of bacteriophage stimulates the production of more bacteriophage by the culture.
2. Bacteriophage is a sexual form of the microbes.
3. Bacteriophage is a filterable form of the microbes whose lysis it produces.
4. Bacteriophage is a virus which propagates exclusively in the bodies of microbes, causing the latter's destruction.

The hypothesis indicated under "1" has been advanced by V. V. Suknev. He holds that bacteriophage is an enzyme which he calls "avisuagen." Avisuagen is produced by microbes in the process of their transformation into a filterable modification.

A similar enzyme producing lysis is postulated by N. N. Zhukov-Verezhnikov, who describes this enzyme as a "necroferment." According to Zhukov-Verezhnikov's conception, the necroferment, i.e., the bacteriophage, is the male sexual element of the microorganism. Upon penetrating into an ordinary microbial cell, it fertilizes the latter, according to Zhukov-Verezhnikov, and division of the cell into much smaller particles representing the progeny results. M. D. Utenkov is in agreement with the assumption that a sexual process is involved in the action of bacteriophage, but holds that sexual cells are formed due to a specific transformation of ordinary vegetative cells into the latter. Utenkov further assumes that the sexual cells copulate, and that phagolysis takes place when a zygote has formed.

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Hypotheses which identify the bacteriophage with filterable modifications of bacteria have been advanced by N. F. Gamaleya (who originally discovered bacteriophagia), V. A. Krestovnikova, and G. M. Bosh'yan. According to Gamaleya, lysis of microbes occurs as a result of accelerated division which is not accompanied by growth, and the filterable form thus derived from the ordinary vegetative cells stimulates division of the ordinary cells when added to a culture of the latter. Krestovnikova and Bosh'yan also assume that bacteriophage is simply a filterable form of the microbe.

The sexual theory is not very convincing. Utenkov has not given a single proof of his assumptions. He forgets that phenomena of vegetative hybridization are prevalent among bacteria. Such phenomena, as Darwin already remarked, lead to results that are closely similar to those produced by sexual hybridization. According to T. D. Lysenko, vegetative hybridization not only gives rise to the same forms of heredity as sexual hybridization, but renews and strengthens the vigor of the organism. While observation with the aid of an electron microscope demonstrated that the bacteriophage has a shape resembling that of a spermatozoon, and that only one particle of the phage penetrates into the bacterial cell, the superficial analogy with the process of fertilization must not be regarded as proving identity of the two processes [bacteriophagia and fertilization].

The hypothesis formulated by Gamaleya and developed by Krestovnikova and Bosh'yan seems plausible. Spontaneous formation of the bacteriophage in old cultures apparently confirms this hypothesis. However, the bacterial form is converted into filterable modifications under a variety of conditions. Filterable forms are obtained not only in phagolyzates, but also from both old and 24-hour cultures of bacteria (the latter showing no sign of autolysis) after they have been submitted to one of a great number of possible treatments. Filterable forms are formed not only during the destruction of cells, but also while the cells are alive. Besides, such filterable forms do not exhibit bacteriophagic action even after they have been passed repeatedly through a culture of bacteria. It is incorrect to assume, as Bosh'yan does, the identity of the bacteriophage with the filterable form on the ground that secondary cultures can be regenerated from phagofiltrates; the latter may contain both the phage which has multiplied in the course of the lysis induced by it and, in addition to that, a filterable form which does not exhibit any bacteriophagic action.

Investigations by means of the electron microscope give the following picture. The phage, provided with a tail, after penetrating into the bacterial cell, brings about lysis of the latter. The disintegration of the cell results in the formation of several hundred phage particles as well as the formation of morphological structures which Zhukov-Verezhnikov refers to as protoplasmic granules. These granules are nothing but the filterable modification of the bacterium, and their morphological structure is distinct from that of the bacteriophage.

How can these contradictory observations be reconciled in the light of Bosh'yan's conception in regard to the identity of filterable bacterial forms with viruses, a conception which we fully share? One may assume that the bacteriophage does form from the filterable modification, but is qualitatively different due to a special form of adaptation. The conditions under which the filterable modification is transformed into the phage comprise a special state of the medium and a peculiar condition of the bacterial population functioning in the capacity of host to the parasitic filterable form. The length of contact of the filterable form with cells which have lost their resistance under unfavorable conditions, are too old, and have accumulated products of metabolism, is also of importance. Attempts to reproduce the particular set of

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conditions which bring about transformation of the filterable form into the bacteriophage have been unsuccessful hitherto, but this does not mean that they will be unsuccessful in the future.

In our opinion, it is certain that the secondary cultures obtained by Bosh'yan from phagofiltrates derive from the ordinary filterable modification rather than the phage, which loses the ability to regenerate into the mature stage of the bacterium.

The questions under consideration are of importance not only from the theoretical standpoint, but also as far as practical applications are concerned. The perfection of bacteriophage as a therapeutic and prophylactic agent as well as the utilization of phagolysates for establishing nonsterile immunity depend on the solution of these questions.

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